Emerging Areas of Organic-Based Magnetism

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Organic-based magnets present an entire new class of materials with a wide range of materials subclasses and a broad range of both conventional and new physics phenomena. Though there is no commercialization of the organic-based magnets at present it is anticipated that there will be applications that take advantage of the new phenomena and new processing techniques. For example, inexpensive disposable large area MRAM made from self-assembled organic-based magnets and semiconductors. This would not displace conventional inorganic-based electronic and magnetic materials but open new opportunities for commercialization.

Grand Challenge: Develop the underlying knowledge base for a new area of inexpensive disposable large area organic-based magnets and organic-based spintronics. Implementation of these new technologies will open up a new means of addressing many societal needs including electronics, energy consumption, health care delivery, and consumer packaging. The program would focus on the underlying new technologies enabled by organics and organic-based magnets including

- Robust spin transporting organic materials such as carbon nanotubes, Figs. 1 and 2.
- Robust spin injectors such as organic semiconductors and embedded inorganic magnetic nanoparticles, Figs. 1 and 2.
- Magnetic organic fully spin polarized semiconductors, Figs. 3 and 4.
- Photoinduced magnetism
- Unconventional magnetic states such as fractal magnets and single molecule magnets for information storage and quantum computing.

Examples are include:

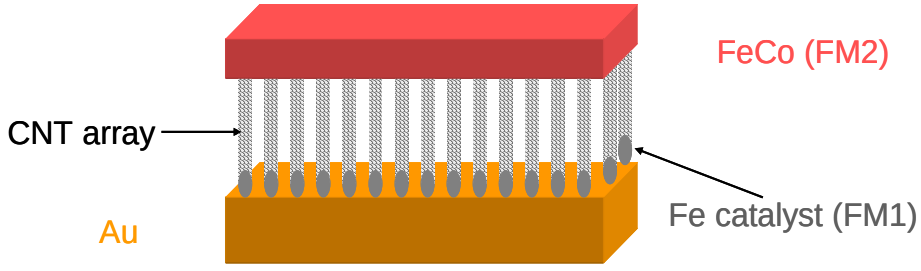

Fig. 1. Schematic of spin valve incorporating Fe nanoparticles as spin injector, 7 micron long carbon nanotubes as spin transporter, and FeCo film as spin analyzer.

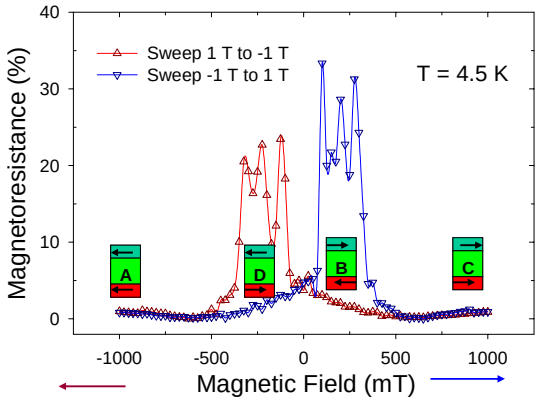

Fig. 2. Spin valve operation of device of Fig. 1.

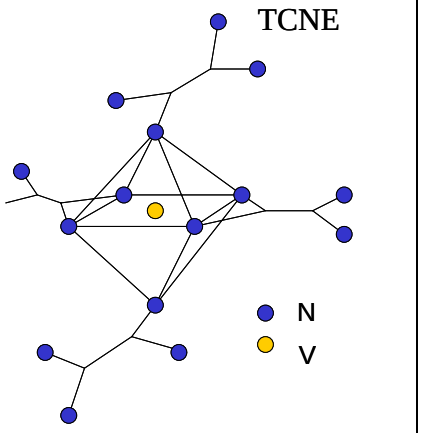

Fig. 3. Schematic illustration of octahedral coordinated $V[TCNE]_2$.

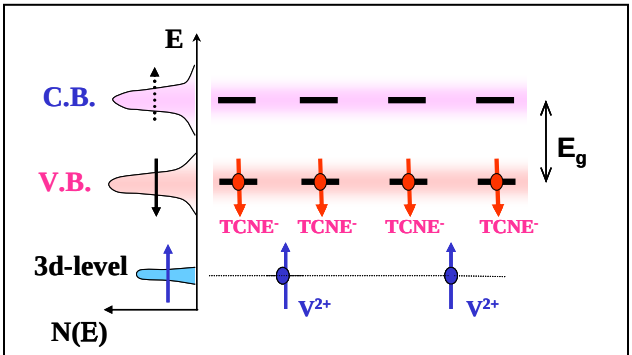

Fig. 4. Schematic illustration of electronic structure of prototype fully spin polarized organic magnetic semiconductor $V[TCNE]_2$.

To accomplish this goal the following approaches are key:

- New materials and new phenomena will demand new facilities
- Local and long range order of these new materials: element specific charge and spin density, spin coherence, glassiness, determine why they magnetically magnetically order?
- Interfaces – What are they? How does magnetism couple across interfaces? Why and how do electron spins cross interfaces without losing their orientation?
- Determine spin spatial and temporal coherence.
- Probe
  - During excitation with light, magnetic field, electric field
  - In small volumes, at nm scale
  - At short times